Unit 7

Water Management

Introduction

Paddy cultivation dominates irrigated agriculture in India and world. Having the required water supply is the most important factor in paddy cultivation. In many tropical region areas, paddy plants suffer either from too much or too less water supply because of irregular rainfall and landscape patterns. Water management includes supplying the required amount of water for optimum crop yield and the best use of limited water supply. Management of water and irrigation system is essential, especially, for farmers who depend on stored water for irrigation. It enables water supply for irrigation during dry season.

"Around 1300–1500mm is a typical amount of water needed for irrigated rice in Asia. Irrigated rice receives an estimated 34–43 per cent of the total world's irrigation water, or about 24–30 per cent of the entire world's developed freshwater resources."

Rice Knowledge Bank, International Rice Research Institute

Session 1: Water Requirement of Paddy

Water is vital for the growth of plants. 'Water requirement' is defined as water required by a crop for optimum growth and development. This requirement may be met by natural precipitation or artificially by irrigation.

Average water requirement

During the entire crop period, the average water requirement of paddy is 1100–1250 mm. It depends on the duration of a variety, characteristics of soil and agro-climatic conditions. However, there is a difference between the field requirement of water and the need

Fig. 7.1: Paddy crop at tillering stage

of the crop to complete its life, depending on the cultivation method adopted. The water requirement of paddy crop under SRI system is 700–800 mm. The average use of water varies from 5 to 8 mm/day.

Critical crop growth stages for irrigation

Critical stage of water requirement refers to a condition, where water stress causes severe reduction in the yield. It is also known as 'moisture sensitive period'. Critical stages of water requirement (when irrigation must be provided) are as follows.

Active tillering

During this phase, there is an increase the number of tillers and height of the plant, which thereby, increases the dry weight.

Panicle initiation

Panicle initiation is the start of the reproductive phase, i.e., the actual panicle or head begins to form just below the flag leaf.

Booting

The entry of paddy plant into the reproductive phase is marked by the bulging of the top leaf stem that conceals the developing panicle. It is called 'booting' or 'flag leaf' stage.

Heading

Heading stage is identified by the emergence of panicle tip from the flag leaf sheath.

Flowering

Flowering begins a day after the completion of the heading stage.

During all these stages, the irrigation schedule must be strictly adhered to unless there is a rain. A reduction in moisture level below the soil saturation level may be avoided. This requirement of paddy plant at the stated growth stages is applicable to all systems of paddy cultivation, i.e., SRI, wet planting and DSR.

Table 7.1: Stage-wise water requirement for paddy

Stage of growth	Water requirement (mm)	Total water requirement (%)
Nursery	44	3.25
Main field preparation	200	16.12
Planting to panicle initiation	458	37
Panicle initiation to flowering	417	33.66
Flowering to maturity	125	10

(Source: Water management, TNAU Agritech Portal)

Practical Exercise

Activity

Visit a nearby paddy field and identify the critical stages for water requirement in the paddy plants being grown there.

Material required: pen, pencil, eraser, notebook, etc.

Procedure

- Visit the nearby paddy field.
- Note down the age of the paddy crops being cultivated there.
- Identify the critical stages of water requirement in the paddy plants.
- Note down your observations and present them before the class.

Check Your Progress

A. Fill in the Blanks

1. The water requirement of paddy crop under SRI system is _____ mm.
2. _____ stage of water requirement refers to a condition, where water stress causes severe reduction in the yield.
3. The flag leaf stage is also known as the _____ stage.

4. The average water requirement of paddy plants for main field preparation is _____ mm.

B. Multiple Choice Questions

1. _____ can be grown under submerged conditions.
   (a) Groundnut (b) Soybean
   (c) Paddy (d) Maize
2. A stage of crop growth that comes before the heading stage is _____.
   (a) active tillering (b) flowering
   (c) booting (d) panicle initiation
3. The average water requirement of paddy during the entire crop life is _____ mm.
   (a) 800–1000 (b) 1100–1250
   (c) 1500–1650 (d) 1600–1850

C. Match the Columns

A (Stage of growth)	B (Water requirement in mm)
1. Nursery	(a) 200
2. Main field preparation	(b) 44
3. Planting to panicle initiation	(c) 417
4. Panicle initiation to flowering	(d) 125
5. Flowering to maturity	(e) 458

D. Subjective Questions

1. What do you understand by water requirement.
2. Describe the different critical crop growth stages of paddy.

SESSION 2: METHODS OF IRRIGATION

Paddy is the only cereal crop that can stand water submergence. Continuous flooding provides best growth environment for the plant. The soil must be kept saturated throughout the growth period. One of the features favourable to crop production is the elimination of moisture stress. In a transplanted field, about 3-cm water level needs to be maintained, which can steadily be increased to 5–7 cm, according to the growth of the plant until the field is drained 7–10 days before the

harvest. In case of wet direct seeded rice, the field must be flooded only once when the plants attain 3–4 leaf stage and light flooding must be ensured in the field. Natural selection pressure (flooding, submergence, drought, biotic stress and nutrient) has led to diversity in paddy agro-ecosystems.

Irrigation methods

Continuous submergence

Continuous submergence of paddy field is practised to increase the availability of nutrients to the plants. It is also helpful in weed management. The submergence of the field with shallow water (up to 5 cm deep) throughout the crop period is favourable for better yield.

Table 7.2: Submergence depth at different stages

Growth stages of paddy crop	Depth of water level (cm)
At the time of transplanting	2
Three days after transplanting	5
Three days after transplanting till maximum tillering stage	2
At maximum tillering stage (only in fertile fields)	Drain the water for three days
From maximum tillering to panicle initiation stage	2
Panicle initiation to 21 days after flowering	5

Source: Water management, TNAU Agritech Portal

Continuous flowing irrigation

- Standing water in lowland rice minimises the irrigation requirement of plants.
- Continuous irrigation increases nitrogen losses from the soil.
- Flowing water from one field to another increases the yield by preventing accumulation of harmful salts in the soil.

Fig. 7.2: Continuous flowing irrigation

Intermittent submergence

- Intermittent submergence implies submergence during the critical stages of the crop. This practice involves maintenance of soil saturation alternated with drying up to hair cracking stage during the various crop stages.
- Intermittent period between saturation and drying varies from one to nine days, depending on the rainfall pattern and soil texture.
- In order to minimise irrigation requirement in the field, intermittent submergence helps save about 30 per cent water.

Rotational irrigation

- This system of irrigation falls within the realm of Alternate Wetting and Drying (AWD) strategy.
- Irrigation water is applied at regular intervals. However, the irrigation interval is adjusted to ensure that there is no water deficit at any period.
- Shallow submergence is advantageous during the critical period of crop growth.
- The SRI system of cultivation uses this strategy of irrigation.

Precautions for irrigation

- Withhold water for few days till the seedlings are established.
- Field-to-field irrigation could carry pathogens from one field to another.
- Drain the field water two days before the application of fertilisers.
- If irrigation facilities are not available, rainwater harvesting must be carried out by making 25–30 cm bunds around the field.
- To minimise water loss by percolation, it is advisable to maintain the water level at a depth of 5 cm or less.
- At the tillering and flowering stage, the water must be drained out completely for 5–7 days, which helps regulate oxygen supply at plant roots and remove toxic substances (sulphides).

Practical Exercise

Activity

Demonstrate rotational irrigation method in a paddy field.

Material required: spade, *khurpi*, gloves, gumboot, etc.

Procedure

- Apply required amount of irrigation water in the paddy field at regular intervals.
- Measure the water depth in standing water with a scale.
- Observe the weed population and plant growth in the field.
- Note down your observations and present them before the class.

Check Your Progress

A. Fill in the Blanks

1. A cereal crop that can withstand water submergence condition is _____.
2. Wet direct seeded rice field needs to be flooded only once when the plants attain _____ leaf stage.
3. Continuous submergence of a paddy field increases the availability of _____.

B. Multiple Choice Questions

1. Intermittent submergence irrigation method saves irrigation up to _____ per cent.
   (a) 20 (b) 30
   (c) 40 (d) 50
2. _____ irrigation method is suitable for preventing accumulation of harmful salts in a paddy field.
   (a) Continuous flowing
   (b) Rotational
   (c) Continuous submergence
   (d) Intermittent submergence
3. How many methods are used for rice irrigation?
   (a) Three (b) Four
   (c) Five (d) Six

C. Match the Columns

A	B
1. Flood irrigation is applied in	(a) Tillering and flowering stage
2. Water level for rice	(b) Alternate wetting and drying
3. Intermittent submergence	(c) up to 5 cm
4. Water is drained out at	(d) Paddy crop

D. Subjective Questions

1. Describe the methods of irrigation used in paddy cultivation.
2. What are the precautions that need to be taken during irrigation?

Session 3: Alternate Wetting and Drying, and Water Use Efficiency

Alternate wetting and drying (AWD)

It is a technique that decreases water consumption in a paddy field without reducing the yield. In this method, irrigation is carried out when there is no stagnant water. The gap between flooded and non-flooded soil can vary from two to over eight days. It depends on various factors, such as weather, crop growth stage and soil type.

Fig. 7.3: Panipipe (field water tube)

Implementation of AWD

To implement this technique, a field water tube is used to monitor water depth in the field. The water level will gradually reduce after irrigation. When the water level reaches 15 cm below the soil surface, irrigation needs to be carried out up to a depth of about 5 cm. Re-irrigation must be carried out to maintain the water level before and after one week of flowering. After flowering, during grain filling and ripening stages, irrigation can be allowed to drop again to 15 cm below the soil surface.

The field water tube for monitoring purpose may be made with 30-cm long (plastic or bamboo) pipe having 10–15 cm diameter to provide clear visibility for the water table and for easy removal of the soil trapped inside. It is perforated with many holes all round to enable water flow in and out of the tube. The tube is hammered into the field, leaving 15 cm top portion to protrude above the soil surface. Make sure not to penetrate deeper than the plow pan surface. Before the tube is ready for work, it is cleaned from the inside so that its bottom is visible. Check if it is installed correctly by pouring water into it and examine for leakage through holes on the tube. After the insertion of the monitoring tube, it is irrigation alert when water level in the tube is 15 cm below the soil surface. Check if water level both inside and outside the tube is same when the field is flooded. If it is not same as outside even after few hours, it is likely that the holes of the tube are choked and the tube needs to be reinstalled or relocated (Fig. 7.3).

Advantages of AWD method

The AWD method helps save water by about 35 per cent without reducing the yield. It increases water use efficiency to about 20 per cent more than flood irrigation method. It improves both the quality and yield, besides minimising the irrigation cost. Hence, AWD method increases the profitability of farmers.

Studies have shown that AWD method also reduces methane (CH_4) emission. CH_4 is produced by anaerobic decomposition of organic matter in wet or flooded paddy fields. When water level is allowed to drop below the soil surface, anaerobic condition is waived for some time till re-flooding.

Water use efficiency

It is the outcome of processes operating during the life of a crop to determine the yield (Y) and evapo-transpiration (ET). Water use efficiency (WUE) can be defined as the yield of plant [grain or whole plant biomass in t/ha (Y), per unit of water used by crop (litres of water lost by crop as ET). In other words, WUE=Y/ET.

Measures to increase water use efficiency

- Puddling and levelling minimise water loss primarily through the soil (percolation losses), thereby, saving water requirement by up to 20 per cent.
- One ploughing with a mouldboard plough, followed by puddling twice gives the best result in terms of crop establishment, water use efficiency and yield.
- Maintain 2–3 cm of water up to seven days of transplanting for better seedling establishment.
- During summer and winter, loamy soil must be irrigated after 1–3 days of disappearance of water in the field.
- Water stress at the time of rooting and tillering stage drastically reduces the yield.
- Due to inadequate drainage conditions, roots of the plants decay and show leaf senescence. There is also a delay in the heading stage resulting in poor quality of grains.

Practical Exercise

Activity

Demonstrate AWD irrigation method in a paddy field.

Material required: field water tube, measuring scale, practical file, pen, pencil, eraser, etc.

Procedure

- Visit a nearby paddy field and select a plot.
- Irrigate it as per the recommendation.
- Insert a field water tube in the irrigated plot.
- Measure the water depth after irrigation and drying.
- Note down your observations in your practical file.
- Present it before the class.

Check Your Progress

A. Fill in the Blanks

1. Alternate wetting and drying technique decreases _____ consumption in a paddy field.

2. Field water tube is used to measure the _____ of water.
3. AWD reduces the emission of _____.
4. WUE stands for _____.

B. Multiple Choice Questions

1. _____ greenhouse gas is emitted maximum in a paddy field.
   (a) HFC (b) CFC
   (c) Co (d) CH_4
2. AWD technique can save water up to _____ per cent.
   (a) 35 (b) 40
   (c) 45 (d) 50
3. AWD method helps increase the _____.
   (a) yield (b) harvesting time
   (c) sowing time (d) number of irrigations

C. Match the Columns

A	B
1. Greenhouse gas	(a) method
2. Water stress during rooting and tillering stage	(b) Saves water
3. Alternate wetting and drying	(c) Drying
4. Soil crack	(d) CH_4
5. Water use efficiency	(e) Reduces the yield

D. Subjective Questions

1. What is the importance of alternate wetting and drying method of irrigation?
2. How can water use efficiency be measured?